WHAT IS CLAIMED:

1. A speed-based control system for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having at least one pressure actuated friction element to establish selectively each of two gearset gear ratios, the adaptive pressure control system comprising:

a first gearset controller for controlling pressure on a first pressure-actuated friction element for the first gearset;

a second gearset controller for controlling pressure on a second pressure-actuated friction element for the second gearset;

the first and second gearset controllers simultaneously controlling friction element pressure for the first and second gearsets during a swap-shift wherein friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of a swap-upshift between two overall gear ratios; and

an adaptive pressure control system configured to boost pressure in the pressure-actuated friction element for the second gearset before a start of torque transfer between the friction elements and to control pressure boost time to a calibrated value to avoid a gear ratio change during pressure boost for the friction element for the second gearset, the control system including a control unit to detect boost time errors during a current shift and an error conversion unit for converting the errors to boost pressure

time adjustments for the friction element for the second gearset during a subsequent shift.

2. A speed-based control system for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having at least one pressure actuated friction element to establish selectively each of two gearset gear ratios, the adaptive pressure control system comprising:

a first gearset controller for controlling pressure on a first pressure-actuated friction element for the first gearset;

a second gearset controller for controlling pressure on a second pressure-actuated friction element for the second gearset;

the first and second gearset controllers simultaneously controlling friction element pressure for the first and second gearsets during a swap-shift wherein friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of a swap-upshift between two overall gear ratios; and

an adaptive pressure control system configured to control pressure to a calibrated value for the pressure-actuated friction element for the second gearset as torque transfer between the friction elements begins, the control system including a control unit to detect errors in the pressure for the friction element for the second gearset during a current shift as the torque transfer begins, and an error conversion unit for converting the errors to pressure adjustments for the friction element for the second gearset during a subsequent shift.

3. A speed-based control system for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having at least one pressure actuated friction element to establish selectively each of two gearset gear ratios, the adaptive pressure control system comprising:

a first gearset controller for controlling pressure on a first pressure-actuated friction element for the first gearset;

a second gearset controller for controlling pressure on a second pressure-actuated friction element for the second gearset;

the first and second gearset controllers simultaneously controlling friction element pressure for the first and second gearsets during a swap-shift wherein friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of a swap-upshift between two overall gear ratios; and

an adaptive pressure control system configured to develop a reduced pressure of calibrated value on the first friction element before a ratio change begins for the first gearset and before a slipping of the first friction element begins, the control system including a control unit to detect pressure errors for the first friction element during a current shift, and an error conversion unit for converting the errors to pressure adjustments for the first friction element during a subsequent shift.

4. A speed-based control system for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having at least one pressure actuated friction element to establish selectively each of two gearset gear ratios, the adaptive pressure control system comprising:

a first gearset controller for controlling pressure on a first pressure-actuated friction element for the first gearset;

a second gearset controller for controlling pressure on a second pressure-actuated friction element for the second gearset;

the first and second gearset controllers simultaneously controlling friction element pressure for the first and second gearsets during a swap-shift wherein friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of a swap-upshift between two overall gear ratios; and

an adaptive pressure control system configured to develop a controlled pressure of calibrated value on the first friction element after a ratio change for the first gearset begins as slipping of the first friction element begins, the control system including a control unit to detect pressure errors for the first friction element during a current shift, and an error conversion unit for converting the errors to pressure adjustments for the first friction element during a subsequent shift.

5. The speed-based control system set forth in claim 1 wherein the transmission has a first speed sensor

for sensing power input shaft speed, a second speed sensor for sensing speed of a power input element of the second gearset and a third speed sensor for sensing speed of a power output element of the second gearset, the speed sensors providing speed information to the adaptive pressure control system to meet shift synchronization requirements.

6. The speed-based control system set forth in claim 2 wherein the transmission has a first speed sensor for sensing power input shaft speed, a second speed sensor for sensing speed of a power input element of the second gearset and a third speed sensor for sensing speed of a power output element of the second gearset, the speed sensors providing speed information to the adaptive pressure control system to meet shift synchronization requirements.

7. The speed-based control system set forth in claim 3 wherein the transmission has a first speed sensor for sensing power input shaft speed, a second speed sensor for sensing speed of a power input element of the second gearset and a third speed sensor for sensing speed of a power output element of the second gearset, the speed sensors providing speed information to the adaptive pressure control system to meet shift synchronization requirements.

8. The speed-based control system set forth in claim 4 wherein the transmission has a first speed sensor for sensing power input shaft speed, a second speed sensor for sensing speed of a power input element of the second gearset and a third speed sensor for sensing speed of a power output element of the second gearset, the speed sensors providing speed information to the adaptive pressure control system to meet shift synchronization requirements.

9. An adaptive pressure control method for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having a pressure-actuated friction element to establish selectively each of two gearset ratios, the method comprising the steps of:

simultaneously controlling friction element pressure for the first and second gearsets during a swap-shift whereby friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of the swap-shift;

applying a calibrated boost pressure on the friction element for the second gearset before a start of torque transfer between the friction elements;

controlling pressure boost time to a calibrated value to avoid a gear ratio change during pressure boost on the friction element for the second gearset;

detecting boost time error during a current shift; and

converting boost time error to boost pressure time adjustment for the friction element for the second gearset, thereby reducing the error during a subsequent shift.

10. An adaptive pressure control method for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having a pressure-actuated friction element to establish selectively

each of two gearset ratios, the method comprising the steps of:

simultaneously controlling friction element pressure for the first and second gearsets during a swap-shift whereby friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of the swap-shift;

applying a calibrated boost pressure on the friction element for the second gearset before a start of torque transfer between the friction elements;

reducing boost pressure to a starting pressure for the friction element for the second gearset;

detecting an error in the starting pressure during a current shift, whereby the pressure on the friction element for the second gearset is too low to begin a shift;

ramping the pressure on the friction element for the second gearset to a value needed to begin a shift;

detecting the time of the pressure ramping during a current shift; and

converting ramping time to a pressure adjustment for the friction element of the second gearset, thereby avoiding pressure ramping during a subsequent shift.

11. An adaptive pressure control method for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having a pressure-actuated friction element to establish selectively each of two gearset ratios, the method comprising the steps of:

simultaneously controlling friction element pressure for the first and second gearsets during a swap-shift whereby friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of the swap-shift;

applying a calibrated boost pressure on the friction element for the second gearset during a pressure boost time before a start of torque transfer between the friction elements;

reducing boost pressure to a starting pressure for the friction element for the second gearset;

detecting torque transfer time from the end of the boost time to a start of ratio change for the second gearset following reduction of boost pressure;

detecting an error in torque transfer time relative to a calibrated value during a current shift; and

converting the error in torque transfer time to a pressure adjustment for the friction element for the second gearset, thereby reducing the error during a subsequent shift.

12. An adaptive pressure control method for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having a pressure-actuated friction element to establish selectively each of two gearset ratios, the method comprising the steps of:

simultaneously controlling friction element pressure for the first and second gearsets during a swap-shift whereby friction element pressure for the second

gearset is increased as friction element pressure for the first gearset is decreased during progression of the swap-shift;

applying a calibrated boost pressure on the friction element for the second gearset before a start of torque transfer;

reducing boost pressure to a starting pressure for the friction element for the second gearset;

detecting overall slip time for the friction element for the second gearset as the friction element for the second gearset gains capacity and the friction element for the first gearset loses capacity;

detecting an error in the overall slip time for the friction element for the second gearset relative to a calibrated value during a current shift; and

converting the error to a pressure adjustment for the starting pressure for the second gearset during a subsequent shift whereby the error is reduced.

13. An adaptive pressure control method for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having a pressure-actuated friction element to establish selectively each of two gearset ratios, the method comprising the steps of:

simultaneously controlling friction element pressure for the first and second gearsets during a swap-shift whereby friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of the swap-shift;

applying a calibrated boost pressure on the friction element for the second gearset before a start of torque transfer;

reducing boost pressure to a starting pressure for the friction element for the second gearset;

detecting an initial slip time for the friction element for the second gearset as the friction element for the second gearset gains capacity and the friction element for the first gearset loses capacity, the initial slip time being measured from the time the friction element for the second gearset begins to slip following torque transfer to a calibrated initial slip time target value;

detecting an error in the initial slip time for the friction element for the second gearset during a current shift; and

converting the error in initial slip time for the friction element for the second gearset to a pressure adjustment for the friction element starting pressure for the second gearset during a subsequent shift whereby the error is reduced.

14. An adaptive pressure control method for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having a pressure-actuated friction element to establish selectively each of two gearset ratios, the method comprising the steps of:

simultaneously controlling a friction element pressure for the first and second gearsets during a swap-shift whereby friction element pressure for the second gearset is increased as friction element pressure for the

first gearset is decreased during progression of the swap-shift;

applying a calibrated boost pressure on the friction element for the second gearset before a start of torque transfer;

reducing boost pressure to a starting pressure for the friction element for the second gearset;

reducing pressure on the friction element of the first gearset as an upshift is commanded to a starting pressure value before the friction element for the first gearset begins to slip;

calibrating a shift progression trigger value for the friction element of the second gearset and a shift progression trigger value for the friction element for the first gearset;

monitoring the time at which each gearset reaches a trigger value;

detecting an error in the start synchronization during a current shift by computing the difference in the monitored time values; and

converting the error to a starting pressure adjustment for the friction element for the first gearset during a subsequent shift whereby the error is reduced.

15. An adaptive pressure control method for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having a pressure-actuated friction element to establish selectively each of two gearset ratios, the method comprising the steps of:

simultaneously controlling friction element pressure for the first and second gearsets during a swap-shift whereby friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of the swap-shift;

applying a calibrated boost pressure on the friction element for the second gearset before a start of torque transfer;

reducing boost pressure to a starting pressure for the friction element for the second gearset;

reducing pressure on the friction element of the first gearset as an upshift is commanded to a starting pressure value before the friction element for the first gearset begins to slip; and

adjusting pressure on the friction element of the first gearset to a starting pressure as the friction element for the first gearset begins to slip.

16. An adaptive pressure control method for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having a pressure-actuated friction element to establish selectively each of two gearset ratios, the method comprising the steps of:

simultaneously controlling friction element pressure for the first and second gearsets during a swap-shift whereby friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of the swap-shift;

applying a calibrated boost pressure on the friction element for the second gearset before a start of torque transfer;

reducing boost pressure to a starting pressure for the friction element for the second gearset;

reducing pressure on the friction element of the first gearset as an upshift is commanded to a starting pressure value before the friction element for the first gearset begins to slip;

controlling pressure in the friction element of the first gearset using closed-loop pressure control during a current shift;

computing closed-loop control effort during slip time of the first gearset; and

converting computed closed-loop control effort to an adjusted pressure in the friction element of the first gearset during a subsequent shift.

17. An adaptive pressure control method for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having a pressure-actuated friction element to establish selectively each of two gearset ratios, the method comprising the steps of:

simultaneously controlling friction element pressure for the first and second gearsets during a swap-shift whereby friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of the swap-shift;

applying a calibrated boost pressure on the friction element for the second gearset before a start of torque transfer;

reducing boost pressure to a starting pressure for the friction element for the second gearset;

reducing pressure on the friction element of the first gearset as an upshift is commanded to a starting pressure value before the friction element for the first gearset begins to slip;

adjusting pressure on the friction element of the first gearset to a starting pressure;

detecting flare as the friction element of the second gearset begins to gain capacity and the friction element of the first gearset begins to lose capacity during a current shift; and

adjusting starting pressure for the first friction element to reduce flare during a subsequent shift.

18. An adaptive pressure control method for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having a pressure-actuated friction element to establish selectively each of two gearset ratios, the method comprising the steps of:

simultaneously controlling a friction element pressure for the first and second gearsets during a swap-shift whereby friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of the swap-shift;

applying a calibrated boost pressure on the friction element of the second gearset before a start of torque transfer between the friction elements;

reducing boost pressure to a starting pressure for the friction element of the second gearset;

calibrating shift progression trigger values for the friction element of the first gearset;

calibrating shift progression trigger values for the friction element of the second gearset;

monitoring the time at which each gearset reaches its trigger values;

detecting an end synchronization error during a current overall shift by computing the difference in monitored times for the first and second gearsets at the end of an overall shift; and

converting the error to a slip pressure adjustment for the first friction element during a ratio change for the first gearset in a subsequent overall shift.

19. An adaptive pressure control method for a swap-shift transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine-driven power input shaft to vehicle traction wheels, each gearset having a pressure-actuated friction element to establish selectively each of two gearset ratios, the method comprising the steps of:

simultaneously controlling a friction element pressure for the first and second gearsets during a swap-shift whereby friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of the swap-shift;

applying a calibrated boost pressure on the friction element of the second gearset before a start of torque transfer between the friction elements;

reducing boost pressure to a starting pressure for the friction element of the second gearset;

calibrating shift progression trigger values for the friction element of the first gearset;

calibrating shift progression trigger values for the friction element of the second gearset;

monitoring the time at which each gearset reaches its trigger values;

detecting an overshoot error by comparing the monitored times for the first and second gearsets at the end of an overall shift during a current shift; and

converting the error to a slip pressure adjustment for the first friction element during a ratio change for the first gearset in a subsequent overall shift.

20. An adaptive pressure control method for a swap-shift transmission for an automotive vehicle powertrain, the transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine to vehicle traction wheels, each gearset having at least one pressure actuated friction element to establish selectively each of two gearset gear ratios, each gearset having a separate controller for its friction element, the method comprising the steps of:

controlling pressure on a pressure actuated friction element for the first gearset;

controlling pressure on a pressure actuated friction element for the second gearset;

simultaneously controlling friction element pressure for the first and second gearsets during a swap-shift whereby friction element pressure for the second gearset is increased as friction element pressure for the first gearset is decreased during progression of a swap-shift between two overall gear ratios;

controlling magnitude and duration of friction element pressure for each gearset and friction element pressure boost time for the friction element of the second gearset at the beginning of a swap-shift whereby calibrated synchronization of the start of a gear ratio change for each gearset during an overall gear ratio change is achieved as friction element slip for the second gearset begins before friction element slip for the first gearset begins, whereby ratio flare is avoided;

establishing multiple control parameters for characteristics of a start of a shift ratio progression for each gearset during a swap-shift;

a first parameter being duration of an initial pressure boost for the second gearset;

a second parameter being pressure at the friction element of the second gearset at the start of a swap-shift;

a third parameter being pressure at the friction element of the first gearset at the start of a swap-shift when friction element slip is near zero;

a fourth parameter being pressure at the friction element of the first gearset at the start of a swap-shift after start of friction element slip for the first gearset;

monitoring multiple operating conditions for the two gearsets during a swap-shift including ratio change during pressure boost at the friction element for the second gearset, the duration of an increasing pressure at the

friction element for the second gearset and actual torque transfer time;

determining errors in one or more monitored operating conditions relative to calibrated values during a current shift; and

adjusting the values of the control parameters in response to determination of one or more errors in the monitored operating conditions, the adjustments being effected during a subsequent shift in accordance with a calibrated parameter adjustment pattern to reduce each operating condition error;

the adjustment pattern being characterized by a calibrated priority scheme whereby an error is corrected in advance of correction of an error of lower priority when simultaneous multiple errors are determined.

21. An adaptive pressure control method for a swap-shift transmission for an automotive vehicle powertrain, the transmission having first and second gearsets arranged in series and defining multiple overall gear ratios as power is transmitted from an engine to vehicle traction wheels, each gearset having at least one pressure actuated friction element to establish selectively each of two gearset gear ratios, each gearset having a separate controller for its friction element, the method comprising the steps of:

controlling pressure in a pressure actuated friction element for the first gearset;

controlling pressure on a pressure actuated friction element for the second gearset;

simultaneously controlling friction element pressure for each gearset during a swap-shift whereby friction element pressure for the second gearset is

increased as friction element pressure for the first gearset is decreased during progression of a swap-shift between two overall gear ratios;

controlling magnitude and duration of friction element pressure for each gearset at the end of a swap-shift between two overall gear ratios whereby calibrated synchronization of the end of a gear ratio change for each gearset during an overall gear ratio change is achieved as friction element slip for the first gearset ends before friction element slip for the second gearset ends, whereby gear ratio overshoot is avoided;

establishing multiple control parameters for characteristics of a start of a shift ratio progression for each gearset during a swap-shift;

a first parameter being duration of an initial pressure boost for the second gearset;

a second parameter being pressure at the friction element of the second gearset at the start of a swap-shift;

a third parameter being pressure at the friction element of the first gearset at the start of a swap-shift when friction element slip is near zero;

a fourth parameter being pressure at the friction element of the first gearset at the start of a swap-shift after start of friction element slip for the first gearset;

monitoring multiple operating conditions for the two gearsets during a swap-shift including ratio change during pressure boost at the friction element for the second gearset, the duration of an increasing pressure at the friction element for the second gearset and actual torque transfer time;

determining errors in one or more monitored operating conditions relative to calibrated values during a current shift including a ratio change during the initial

pressure boost for the second gearset and actual torque transfer time; and

adjusting the values of the control parameters in response to determination of one or more errors in the monitored operating conditions, the adjustments being effected during a subsequent shift in accordance with a calibrated parameter adjustment pattern to reduce each operating condition error;

the adjustment pattern being characterized by a calibrated priority scheme whereby an error is corrected in advance of correction of an error of lower priority when simultaneous multiple errors are determined.

22. The adaptive pressure control method set forth in claim 20 wherein the multiple measured operating conditions include also overall slip time for the friction element of the second gearset, initial slip time of the friction element of the second gearset, and synchronization error at the start of a swap-shift measured in time.

23. The adaptive pressure control method set forth in claim 22 wherein the multiple measured operating conditions include also synchronization error at the end of a swap-shift measured in time, ratio overshoot error at the end of a swap-shift measured in shift progression and cumulative integrated controller effort for the controller for the friction element of the first gearset.

24. The adaptive pressure control method set forth in claim 20 wherein multiple control parameters are adapted during a swap-shift.

25. The adaptive pressure control method set forth in claim 24 wherein selected control parameters are adapted using detected errors in multiple measured operating conditions.

26. The adaptive pressure control method set forth in claim 24 including the step of prioritizing the use of multiple measured operating conditions using a precalibrated priority schedule as current swap-shifts are adapted to improve shift quality during a subsequent swap-shift.

27. The adaptive pressure control method set forth in claim 20 wherein the control parameters for shift ratio progression for each gearset comprise adjusted parameter values as errors in the multiple measured operating conditions during a current shift are converted to pressure and time adjustments for use in a subsequent shift.

28. The adaptive pressure control method set forth in claim 21 wherein the control parameters for shift ratio progression for each gearset comprise adjusted parameter values as errors in the multiple measured operating conditions during a current shift are converted to pressure and time adjustments for use in a subsequent shift.

29. The adaptive pressure control method set forth in claim 27 wherein the controllers for the gearsets learn the adjusted parameter values for their respective gearsets during a current shift for use in a subsequent shift.

30. The adaptive pressure control method set forth in claim 28 wherein the controllers for the gearsets learn the adjusted parameter values for their respective gearsets during a current shift for use in a subsequent shift.